

MASS AUDIT STUDY PROTOCOL

THE SAN JOSÉ/SANTA CLARA WATER POLLUTION CONTROL PLANT

Cities and Agencies Tributary to the San José/Santa Clara Water Pollution Control Plant:
San José, Santa Clara, Milpitas, Cupertino Sanitary District, West Valley Sanitation District
(including Campbell, Los Gatos, Monte Sereno, Saratoga), County Sanitation Districts 2-3,
Sunol and Burbank Sanitary Districts

**Program managed by the City of San José, Environmental Services Department
Watershed Protection Group**

MASS AUDIT STUDY PROTOCOL

PREFACE

The Mass Audit Study program, specifically this document, was originally developed after extensive study and review of pollution prevention efforts at industrial facilities in Santa Clara County. This document will provide guidance and establish the industry parameters when preparing and conducting the Mass Audit Study (MAS).

This document includes several forms that will assist Dischargers in gathering data, evaluating waste minimization options, and reporting the results. Many of these forms were taken from manuals prepared by the US Environmental Protection Agency (EPA), the San José/Santa Clara Water Pollution Control Plant (WPCP) MAS Protocol of October 1993, and the California Department of Toxic Substances Control. Additionally, information from waste minimization studies conducted by the WPCP, the City of Palo Alto, and the City of Mountain View has been incorporated into this document.

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ABBREVIATIONS

City	City of San José
Director	The Director of the Environmental Services Department
ESD	Environmental Services Department
EPA	Environmental Protection Agency
IU	Industrial User
Discharger	Industrial Waste Discharger
MAS	Mass Audit Study
MECL	Mass Equivalent Concentration Limit
MFR	Maximum Feasible Reduction measure
NPDES	National Pollutant Discharge Elimination System
POTW	Publicly Owned Treatment Works
RCM	Reasonable Control Measure
RCMP	Reasonable Control Measures Plan
RO	Reverse Osmosis
RWQCB	Regional Water Quality Control Board
PCB	Printed Circuit Board
SMR	Self-Monitoring Report
South Bay	San Francisco Bay South of the Dumbarton Bridge
WMP	Waste Minimization Plan
WPCP	San José/Santa Clara Water Pollution Control Plant
WTS	Waste Treatment System
gpd	gallons per day
MGD	million gallons per day
mg/l	milligrams per liter
µg/l	micrograms per liter
ppd	pounds per day
ppm	parts per million
ppb	parts per billion

BACKGROUND

The City of San José (City) faces the challenge to preserve one of the most important estuaries in the United States alongside a socially and economically complex urban community. Approximately one million residents and 16,000 commercial and industrial businesses, including many of the leading high-technology firms in the country, are located within the San José/Santa Clara Water Pollution Control Plant's (WPCP) service area. The City operates the WPCP according to the terms of its National Pollutant Discharge Elimination System (NPDES) Permit. It is responsible for limiting treatment plant discharges of toxic pollutants to the South San Francisco Bay (South Bay).

Copper and nickel are two pollutants of concern specifically identified in the South Bay. Industrial Users (IUs) or Industrial Waste Dischargers (Dischargers) are the best understood sources of copper and nickel, having been evaluated by a number of government and private programs. These earlier studies suggest that about 20% to 30% of the copper and 50% to 60% of the nickel entering the WPCP come from industrial operations. In 1993, the City identified specific IUs whose wastewaters contributed 85% of the industrial copper and 85% of the industrial nickel discharged to the WPCP. The City required each of these IUs to prepare and submit a Mass Audit Study (MAS). Upon approval by the City, the IUs implemented Maximum Feasible Reduction measures (MFRs) as identified in the approved MASs to reduce their discharges of copper and/or nickel to the Sanitary Sewer System. Copies of previously completed MASs and the MAS Summary Report are available for review. For further information, contact your Source Control Inspector.

Other sources of copper and nickel are significant, yet more difficult to evaluate, because they are diverse, wide-spread, and not technically well-understood. Nevertheless, additional studies are being conducted to develop more technical data on the other potential sources of copper and nickel. The City has integrated several pollutant control programs through a watershed management approach known as the Clean Bay Strategy (CBS) which is presented in *"Pollution Prevention Strategy for a Clean Bay, Including Proposed Local Limits for Copper, Nickel, and Cyanide"* (October 1994). The individual elements of the CBS include:

- Copper-, Nickel-, and Cyanide-Control Programs.
- Source Identification Programs.
- Residential Pollution Prevention & Outreach Programs.
- Commercial Pollution Prevention & Outreach Programs.
- Industrial Incentive Programs.
- Water Conservation Programs.

- WPCP Optimization Programs.
- Other Key Mass and Flow Reduction Programs, including the South Bay Water Recycling Program, the Nonpoint Source Program, and the New Industry/Development Program (October 1993).

This document is a revised version of the original 1993 Mass Audit Study Protocol. It describes the information necessary for the submittal of the MAS. It is not the intention of the City to duplicate efforts; therefore, whenever possible, use your Industrial Wastewater Discharge Permit Application, Hazardous Waste Source Reduction & Management Review Act of 1989 (SB-14) and the Hazardous Materials Management Plan/Business Plan (HMMP) as a source of the information for completing the MAS. As technology changes, the City may periodically revise this MAS protocol. Any questions regarding the contents of the MAS should be forwarded to your Source Control Inspector.

The use of these guidelines cannot be interpreted as protection against enforcement action. The IU must ensure compliance with all local, state, and federal regulations. Additionally, the City will not endorse or reject a project because of any specific consultant, vendor, or product line mentioned.

INTRODUCTION

The purpose of this document is to provide guidance and establish parameters for IUs when preparing the MAS. The *Mass Audit Study Protocol* describes the format required for the MAS. Use existing information where possible. Sources of information include Industrial Wastewater Discharge Permit Applications, HMMPs, SB-14 Source Reduction Plans, Waste Minimization Plans (WMP), Process Operation Records, and Original Construction Drawings. For further questions regarding the contents of the MAS, please contact your Source Control Inspector at (408) 945-3000.

What is the Mass Audit Study (MAS)?

“Mass Audit Study” means an investigation of pollution and source reduction measures performed by or for an Industrial User, pursuant to Audit Protocols adopted by the Director, to analyze the volume and concentration of nickel, copper, and/or any other Priority Pollutant identified in regulations adopted by the Director in an Industrial User’s process streams and discharge, and to identify the Maximum Feasible Reduction Measures available to the Industrial User (San José Municipal Code, Section 15.14.325).

How do I Know if I should Complete the MAS?

You are required to complete the MAS if you meet any one of the following criteria:

- You are a Group 1 Discharger (San José Municipal Code, Section 15.14.285):
 - A. *Group 1 Discharger means an IU which typically uses copper or nickel as part of its operational process and which discharges Industrial Wastes into the Sanitary Sewer System containing nickel in excess of .005 mg/l or copper in excess of .05 mg/l, and whose discharge contains in excess of .04 pounds per day (ppd) nickel or .09 ppd copper.*
 - B. *For the purpose of subsection A above, the pounds of nickel and copper contained in an Industrial User’s discharge shall be determined by multiplying the Industrial User’s average Process Flow times the Average Concentration of nickel or copper measured in the Industrial User’s discharge as shown by Composite Sampling, including but not limited to self monitoring sampling.*
 - C. *For the purpose of subsections A and B above, average Process Flow and Average Concentration for any Industrial Discharger discharging into the Sanitary Sewer System prior to April 1, 1993, shall be calculated on the basis of sampling for the twelve (12) month period from April 1, 1992 through March 31, 1993, and for any other Industrial*

Discharger for the twelve (12) month time period preceding the date of application for reissuance of a discharge permit, or, in the case of an application for a new permit, on the basis of the projected Process Flow shown in the Industrial User's Wastewater Discharge Permit application and the projected Average Concentrations shown in the Industrial User's Wastewater Discharge Permit application.

- You are a Group 2 Discharger who has implemented approved Reasonable Control Measures Plan (RCMP) control measures and are in significant non-compliance with your discharge limits for copper and/or nickel.
- You are a Group 2 Discharger who elected to perform a MAS.

What are MFRs?

Copper and nickel reduction should occur by implementing Maximum Feasible Reduction measures (MFRs). This includes undertaking all projects and “functionally interdependent” groups of projects that the MAS indicates are “Cost Effective” and “Technically Feasible.”

Cost Effective

“Cost Effective” means that total project costs, if financed over a five (5) year period at the prime interest rate published in the Wall Street Journal plus two percent (2%) at the time the project costs are being determined, do not exceed the total savings that would be generated by the project during the same five (5) year period. Project costs shall also be considered Cost Effective, if financing assistance is available to the Discharger, from the City or any other source, at a lower rate and the project costs, if financed over a five (5) year period at that rate does not exceed the total savings that would be generated by the project during the same five (5) year period (San José Municipal Code, Section 15.14.250).

An exception may be allowed on a case by case basis, where the discharger can show that the prime interest rate published in the Wall Street Journal plus two percent (2%) is not obtainable.

Technically Feasible

A waste minimization measure (or group of interdependent measures) shall be deemed Technically Feasible if it has a reasonable expectation of reducing copper, nickel, and/or wastewater flow, and can be used without significantly affecting production quality or throughput.

Functionally Interdependent

Groups of projects may be interdependent in such a way that they need to be done together in order for Technically Feasible or Cost Effective waste minimization to occur. Examples include:

1. The use of ion exchange to treat rinsewater is not always cost effective. However, the use of static dragout tank(s) and counter-current rinses prior to ion exchange may make the entire system cost effective. The reduced concentration and flow may make it possible to use a smaller and less expensive ion exchange unit.
2. Filtration is usually needed both before and after an ion exchange unit. These filters should be included together with the ion exchange as interdependent measures.

What are RCMs?

Reasonable Control Measures (RCMs) are defined in the San José Municipal Code, Section 15.14.360, as:

“...control technologies, Best Management Practices, source control practices and waste minimization procedures which prevent or reduce the introduction of pollutants to the Sanitary Sewer System and are determined by the Director to be Cost Effective for particular industry groups, business types, or specific industrial process.”

Because RCMs have been found to be cost effective in most applications, economic evaluations are not required to determine corresponding payback periods. All applicable RCMs must be in place or scheduled for implementation before your MAS is approved. If a RCM is found to be non-applicable, an explanation must be included in the submittal of your MAS.

What is a MECL?

A Mass Equivalent Concentration Limit (MECL) is a mass-based discharge limit for copper or nickel and is calculated using the projected annual mass of copper and/or nickel and the projected annual process flow from the IU's discharge after the installation of applicable MFRs as indicated in the IU's MAS.

$$\frac{Cu / Ni(lbs / yr)}{ProcessFlow(gallons / yr) \times 8.34 \times 10^{-6}} = MECL(mg / l)$$

When is a MECL Enforced?

A MECL is a rolling 12-month average of representative composite samples. The minimum frequency of self-monitoring will vary from one sample per week to one sample per 6 months, depending on industry type and discharge history. A violation occurs if the monthly average concentration of the pollutant is greater than the MECL and the annual average for the previous 12 months exceeds 110% of the MECL for that pollutant.

Example: MECL for copper is 1.0 mg/l

Average discharge for June 1996, including Self -monitoring Report (SMR) and Publicly Owned Treatment Works (POTW) monitoring data, was 1.15 mg/l Cu. Since the June monthly average discharge for copper is greater than the 1.0 mg/l MECL for copper, the Source Control Inspector would average the discharge data of 24-hour composite samples (both SMR and POTW) over the previous 12 months, as shown below.

June 1995 - May 1996: 1.12 mg/l Cu

If the monthly average discharge for copper from the previous 12 months is greater than 110% of the MECL or 1.10 mg/l Cu, then the IU is in violation of their MECL. In the above example the IU is in violation.

If the average concentration for copper discharged from the 12 previous months is less than 110% or 1.10 mg/l Cu, the IU would not be in violation of their MECL in June 1996, even though the June 1996 monthly average by itself exceeds 110% of the MECL. The 1.12 mg/l Cu would be entered into the database, which is used to calculate future discharge levels.

How do I get a MECL?

Complete the MAS, including an implementation schedule, 120 days after it becomes a permit condition. Upon completion and approval of the MAS, MECLs for copper and/or nickel will be issued.

Can I Amend my MAS and have my MECL Recalculated?

Yes. An application for the revised MAS and MECL may be submitted, along with the appropriate fees, at any time when either of the following two conditions exist:

1. Production increases or process changes are projected to cause the IU to exceed their MECL
2. The IU is proposing to implement a water conservation project that will result in exceedance of their MECL, and the mass discharge does not exceed the mass that was used in calculating their MECL.

When must I Amend my MAS?

An IU must amend their MAS if their average process flow exceeds the average process flow used in calculating their MECL by 25% for 6 consecutive months. An addendum to the MAS must demonstrate that the increased flow is solely due to increased production and that no further MFRs will reduce either the process flow or average concentration resulting from the increased flow. If this cannot be demonstrated, the IU shall submit a revised MAS based on the increased process flow, with the appropriate fees.

Can I Assume that my MECL will be Recalculated if I Submit an Amendment?

No. Enough information must be submitted and verified on site to demonstrate that the exceedance of the MECL will be solely due to increased production, process changes or implementation of a water conservation project by the IU and that no further RCMs or MFRs are available to reduce either process flow or average concentration.

GENERAL REQUIREMENTS

How do I Prepare the MAS?

The step-by-step preparation of the MAS is described below and in the flow chart on page 8. There are three key parts of this effort:

1. Decide Upon a Course of Action

Review the MAS Protocol and confirm that it applies to your business. Hold a “kick-off” meeting with the City and provide an address and phone number for the person who will head your MAS team.

2. Conduct the MAS

You are encouraged to contact the City during the preparation of your MAS. Bringing questions and comments up early will streamline the review and approval process. Throughout the MAS Program, City staff will be available to answer questions and to interpret Protocol requirements. In addition, copies of previously completed MASs will be made available.

The City welcomes comments and suggestions concerning how assistance could be provided to your facility throughout the process of completing the MAS and how the process could be improved.

3. Report the Results to the City

Complete and submit all of the required worksheets to the City within 120 days of notification. Assemble all of your calculations and work papers into files, and hold these on-site for the City to review.

Proprietary information, as defined in the Industrial Wastewater Discharge Permit Regulations, can be kept on-site. However, a version without proprietary information will be required for the City’s files. A City Environmental Engineer or Source Control Inspector will have to verify the information before the MAS can be considered complete.

After submission of the MAS by the facility and approval by the Director of the Environmental Services Department (ESD) or an authorized designee, progress reports on the implementation of RCMs and MFR projects should be submitted with SMRs until all projects have been completed.

When must this Process be Completed?

New Group 1 Dischargers must complete the implementation schedule of projects within 1 year after the submittal of MAS. Dischargers with approval from the City may extend the implementation schedule to incorporate costly capital investment projects or receive a compliance schedule to extend the implementation period.

Submittal of the MAS should allow sufficient time for review and approval by the City and implementation of approved measures. All IUs are encouraged to complete this process as soon as possible.

What do I Submit?

Prepare the MAS report that includes an evaluation of each of the industrial processes that generates wastewater at your facility. The MAS should include the following:

1. COVER SHEET

Complete the attached cover sheet in its entirety.

2. MAS WORKSHEETS

The worksheets are categorized into the following sections:

Section 1 - Organization Checklist

Section 2 - MAS Cost Summary

Section 3 - Facility Data

Section 4 - Facility Process Information

Section 5 - Reasonable Control Measure Checklists

Section 6 - Waste Minimization Projects Evaluation

Section 7 - Waste Minimization Projects Summary

Section 8 - Implementation Schedule

3. INFORMATION and IMPLEMENTATION CERTIFICATION

The purpose of this section is to certify that the MAS has been completed by the appropriate personnel, that obligations of the plan are understood, and that the information included in the submitted MAS is true. The certification must be signed by both the person who prepared the plan and the Executive Officer that supervised the preparation of the MAS.

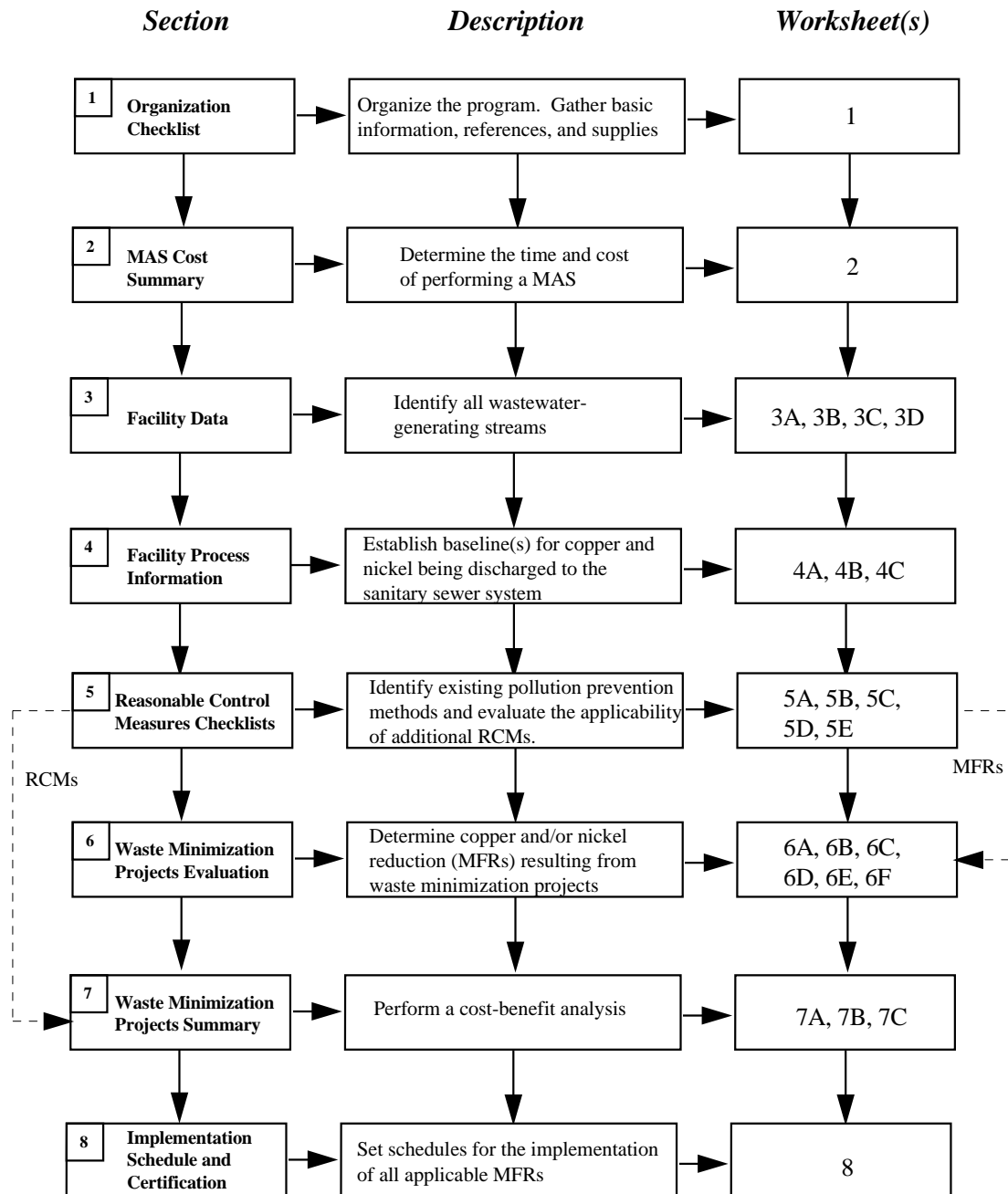
How do I Determine a Baseline?

As indicated in the San José Municipal Code, Section 15.14.285(C): Average Process Flow and Average Concentration, for any Industrial Discharger discharging into the Sanitary Sewer System should be calculated on the basis of sampling for the 12-month time period preceding the date of application for reissuance of a discharge permit, or the 12-month time period prior to beginning the MAS. The baseline average process flow and average concentration is determined from data over a 12-month period.

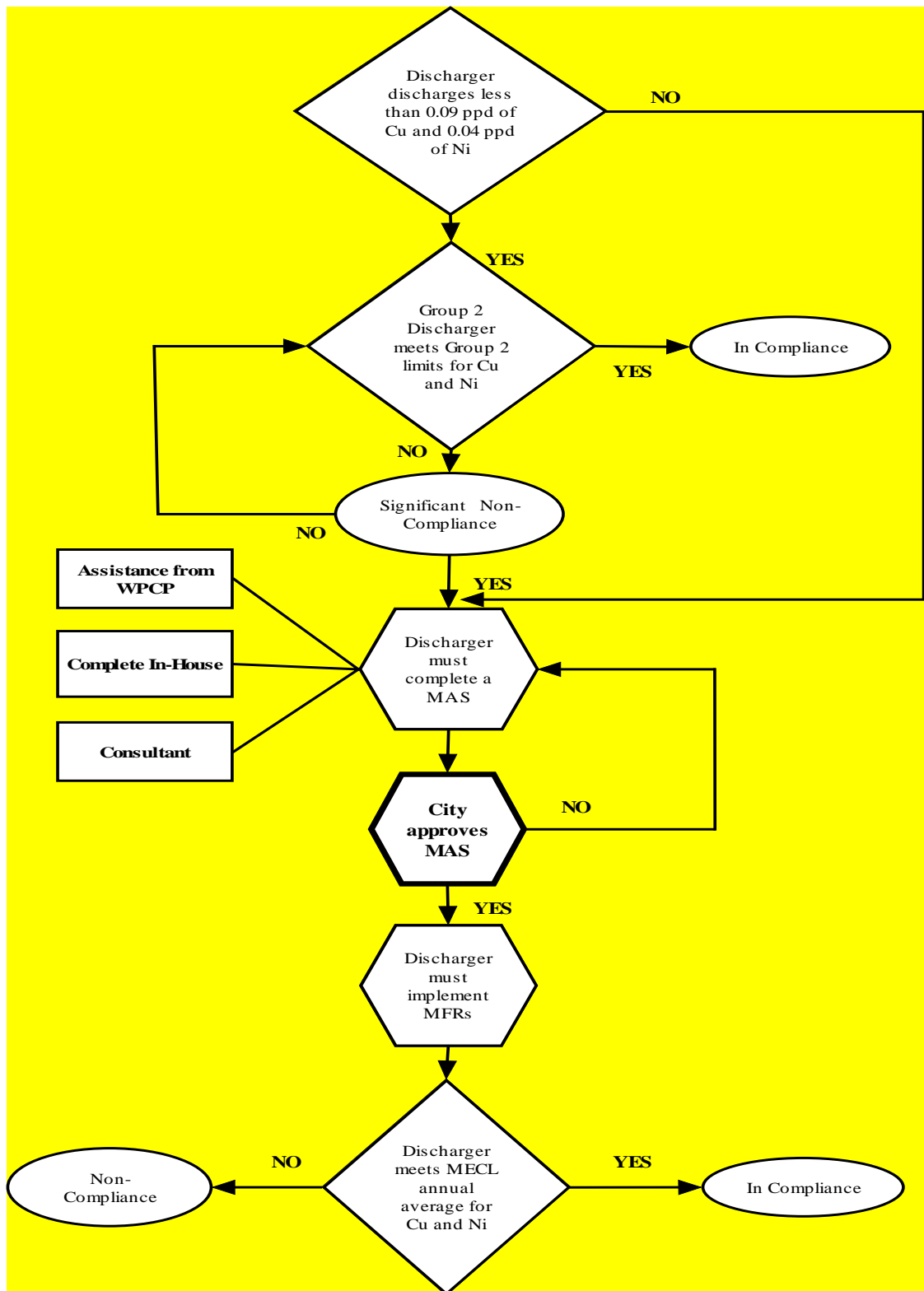
In the case of a New Discharger applying for a permit, a baseline should be determined from the projected Process Flow and the projected Average Concentrations shown in the IU's Wastewater Discharge Permit application. This will be the baseline unless a specific time frame is approved by the City. The projected flows and concentrations must be well-documented and are subject to approval by the City.

MASS AUDIT STUDY

Process Flow Chart



MASS AUDIT STUDY Compliance Flow Chart



MAS COVERSHEET

Purpose

To provide general information about the IU and indicate a contact person for questions regarding the MAS.

Procedures

- Enter facility information with a brief explanation of your facility's major products, major operations, and facilities.
- Use the address where your industrial discharge point is located.
- Include your WPCP Industrial Wastewater discharge permit number.

SECTION 1: ORGANIZATION CHECKLIST

Purpose

To get organized for conducting the MAS.

Procedures

Worksheet 1

This worksheet is a checklist of the items that must be completed to get ready for the MAS.
Check off each task as completed.

SECTION 2: MAS COST SUMMARY

Purpose

To determine the time and cost of performing the MAS.

Procedures

Time Log

This worksheet may be used to track the amount of time that each employee spends working on the MAS. This information is for your use and does not need to be submitted as part of the MAS.

Worksheet 2

This worksheet is a summary of the cost and/or time required to complete the MAS for the tasks listed. Additional activities associated with the preparation of your MAS that are not specifically listed on the worksheet may be included in the last category, "other."

SECTION 3: FACILITY DATA

Purpose

To prepare information on the existing operation of the facility and identify copper and/or nickel containing wastestreams.

Sources of Information

- Hazardous Materials Management Plan (HMMP)
- SB-14 Source Reduction Plan
- Process Operation Records
- Original Construction Drawings
- Industrial Wastewater Discharge Permit Application

Procedures

Worksheet 3A

Prepare a site map of your facility showing the major structures including RO system, WTS, etc.

Worksheet 3B

Include detailed diagrams of your process areas where wastewater is generated, stored, and treated (e.g. plating tank layout diagram).

Worksheet 3C

Prepare a Summary Process Flow Diagram. A sample diagram is provided in Figure 1. The diagram should include the following:

- Each industrial process discharging process wastewater.
- The path and direction of all wastewater flow. (Example: Either to batch treatment, continuous treatment, or directly to sample box).
- The relative location of the RO system, DI system, treatment systems, flowmeters, and wastewater sampling point(s). Flowmeters should be identified as influent, influent dedicated to process, or effluent. Sample points should be identified as in the permit.

Worksheet 3D

For each industrial process in the Summary Process Flow Diagram, prepare a detailed Process Flow diagram. Sample diagrams are provided in Figure 2 and Figure 3.

Place numbers on the diagrams to show the process and tank numbers (e.g., P1, T1, etc.). These numbers should correspond to the process numbers, stream numbers, and tank numbers used in worksheets 3A, 3B, and 3C. If you have an equivalent numbering system, you may use those numbers as long as it is clear.

The diagrams should include:

- All process tanks. Include name, function (i.e. static rinse, recirculating rinse: filtered, etc.).
- The direction of product work flow and industrial process wastewater flow.

In addition to the process diagrams, you should also include a detailed diagram of the wastewater treatment systems (including batch, continuous, neutralization, and other treatment units).

Sample Facility Block Flow Diagram

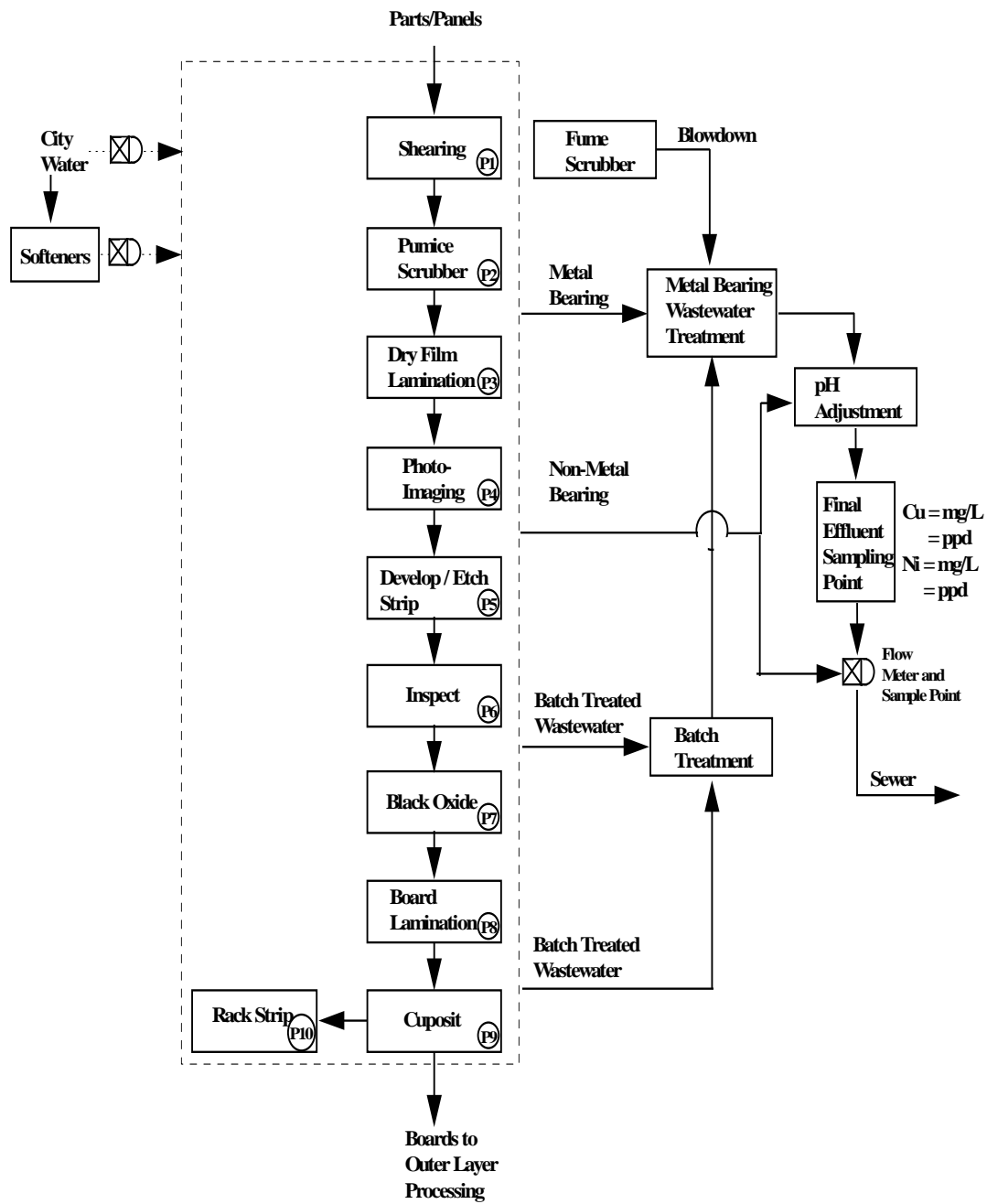


FIGURE 2
Sample Detail Process Block Flow Diagram

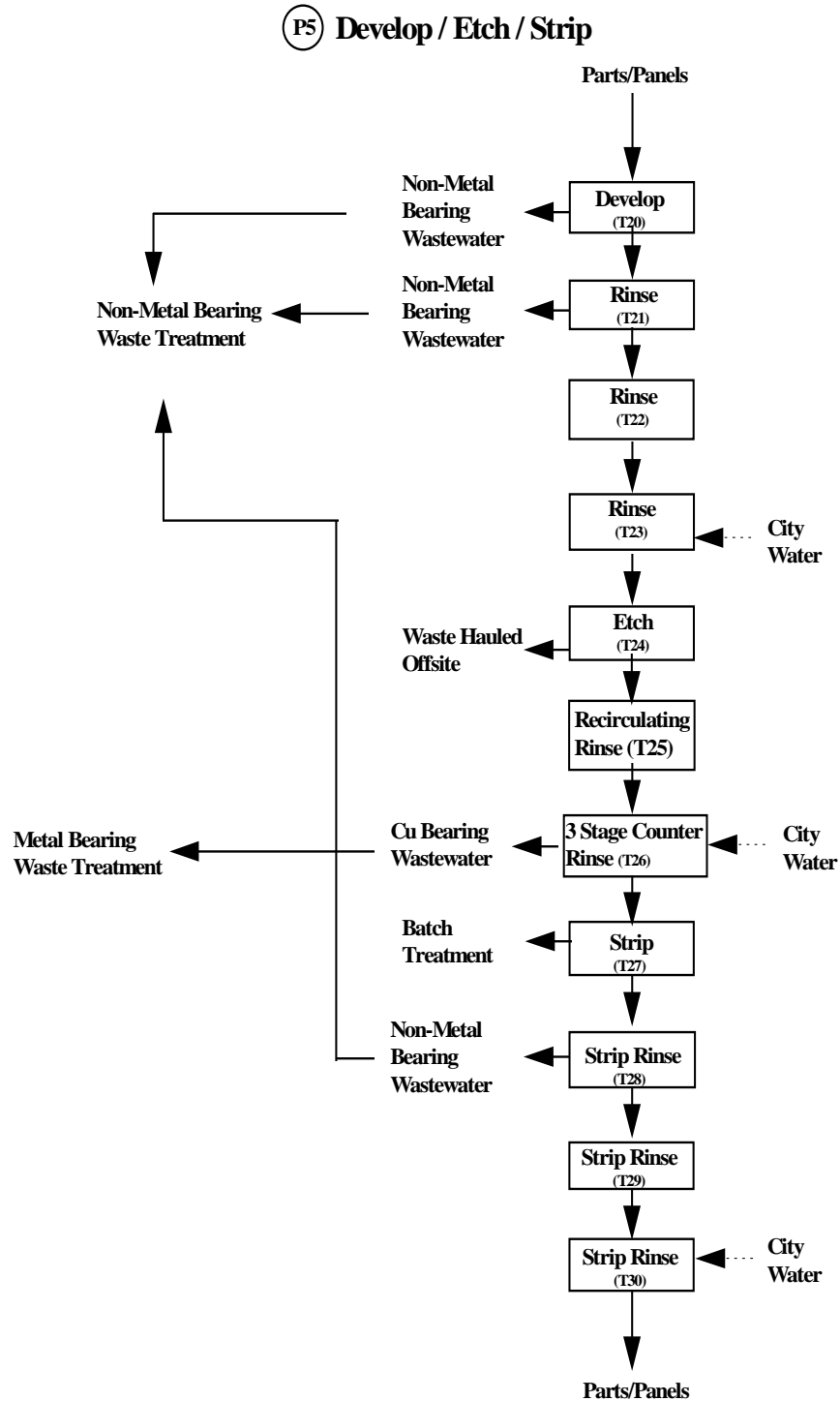
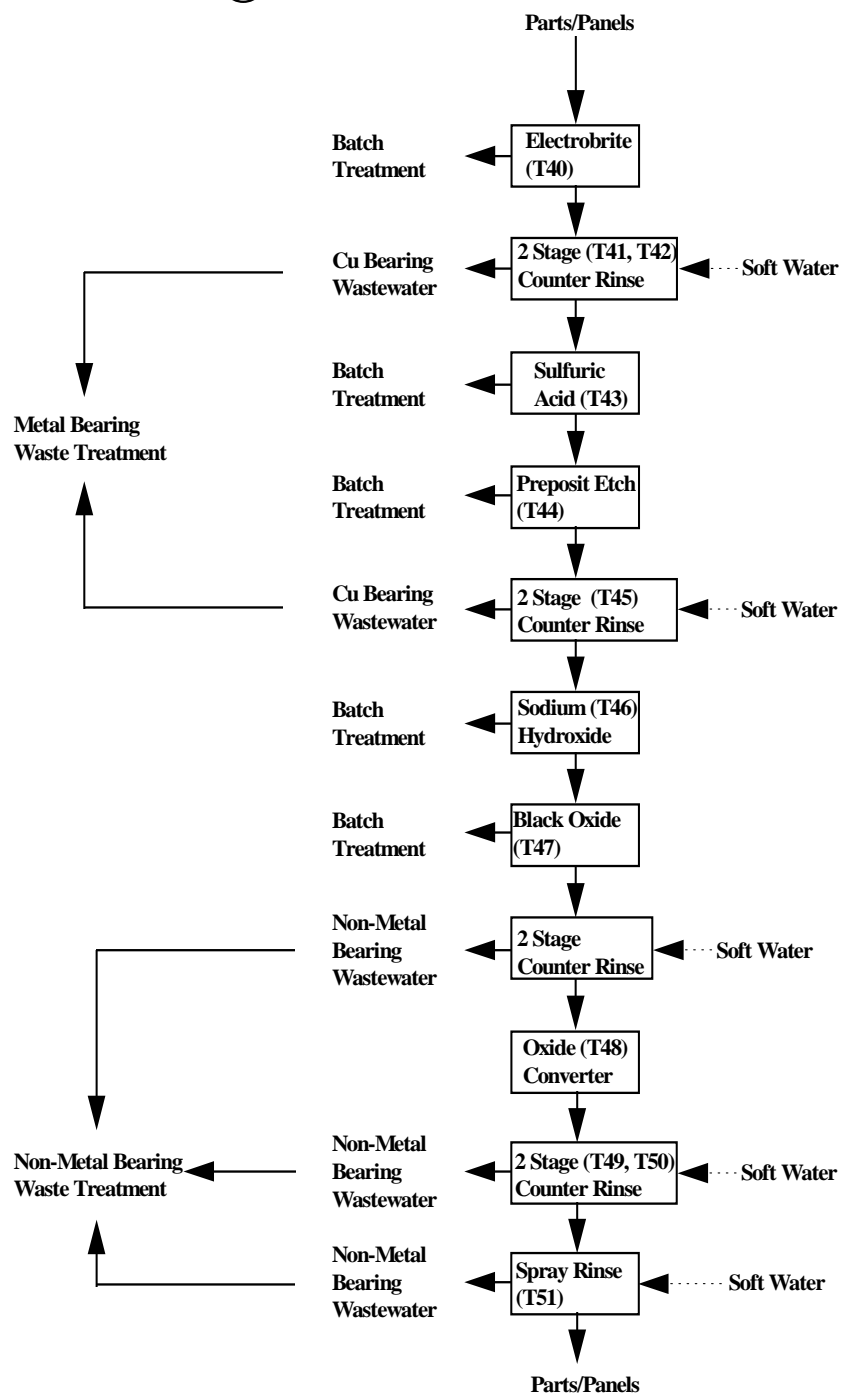


FIGURE 3
Sample Detail Process Block Flow Diagram

(P7) Black Oxide Process



SECTION 4: FACILITY PROCESS INFORMATION

Purpose

To collect, measure, and record data on the existing operation of the facility to establish baseline amounts of copper and/or nickel being discharged into the Sanitary Sewer System. This baseline will include production rate, operating factors, and wastewater flow for an average operating day.

Sources of Information

- Hazardous Materials Management Plan (HMMP)
- SB-14 Source Reduction Plan
- Process Operation Records
- Waste Disposal Records

Levels of Detail

Physical: As needed, develop a mass balance for each Facility, Plant, Process, or Tank for copper and/or nickel processes.

Time: Compute your average daily mass balance.

Chemistry: Use standard formulas, specific chemical use data, or lists of proprietary chemicals.

Concentration: Use milligrams per liter (mg/l).

Conversion Factor: $8.34 \times 10^{-6} = 2.205 \text{ lb/kg} \times 3.785 \text{ liter/gal} \times 1.0 \text{ kg}/10^6 \text{ mg}$

Weights: Use pounds per day (ppd).

$$\text{ppd} = \text{concentration, mg / l} \times \text{flow, gpd} \times 8.34 \times 10^{-6}$$

Volume: Use gallons.

Mass Balance: Closure within 10% on a mass basis.

Procedures

Worksheet 4A

Complete one worksheet for each process. Identify the tanks using the ID number as listed in Worksheet 3D (T1, T2, ...) and supply the following information.

- Indicate if process components include copper and/or nickel.

- List tank flow rate. Tank flow rate should be a workday average in gallons per day (gpd). For static or recirculating rinses, calculate the average flow from the frequency of changes, bail outs, etc.
- List average tank volume in gallons. Average tank volume is the actual volume of the contents of the tank.
- Include average daily usage for input materials containing copper and/or nickel in mg/l and ppd.
- Include average daily waste generation rates for copper and/or nickel in mg/l and ppd.
- State method of treatment used (i.e., batch, continuous, off-site hauling, neutralization, ion exchange or recycled). A key for abbreviations is located on the bottom left corner of the worksheet.
- Compute totals for each process.

Worksheet 4B

This form summarizes all process streams described in Worksheet 4A.

- Indicate if hazardous components include copper or nickel. If a process contains both metals, list the entry once for copper and once for nickel.
- “Flow Rate” will be the Process Total “Workday Flow Rate” on Worksheet 4A.
- “Daily Ave.” will be the Process Total “Output waste Generation” (in ppd) on Worksheet 4A for the chosen constituent.
- Indicate the amount of waste (in gpd and ppd) that is treated by batch, continuous, and offsite treatment for each of the process streams. For this form, offsite disposal consists of shipping concentrated spent solutions, but **does not** include wastewater sludge.

Worksheet 4C

This form summarizes the facility process totals.

Worksheet 4C, indicate the baseline time period for your facility.

- The baseline should be calculated to reflect operating data for the entire preceding year.
- If any process was not operating continuously throughout the entire preceding year, or if you do not have sufficient operating data, you may use a different baseline time period. Baseline time period is subject to approval by the City.
- Notify the City as early as possible of the intended dates for your baseline time period.

- Include production rate or the number of units produced per operating day.

Worksheet 4C, determine the baseline operating factors of the process.

- Include how many hours per day, hours per week, and days per year the process operates.

Worksheet 4C, “Total to Waste Treatment,” will be the Facility Total for “To Waste Treatment” on Worksheet 4B.

- Enter the total workday flow rate to waste treatment for the facility in gpd. Fill in the total amount of copper and/or nickel sent to waste treatment in ppd.

Provide detailed information on the final disposal practice at the facility in the lower right section of the worksheet.

- Include the copper and/or nickel discharged to the sewer in mg/l. Also include flows in gpd and ppd.
- “Chemistry” represents spent process baths, concentrated baths, etc. that are disposed of off-site.
- “Other” includes material such as ion exchange resin and scrap metal that are disposed of off-site.

To perform a treatment mass balance:

Total to Waste Treatment (ppd) = Total to Final Disposal (ppd)

- The total amount of copper and/or nickel going to waste treatment should theoretically equal the total amount of copper and/or nickel going to final disposal.
- A facility’s calculations should be within 10%.
- If 10% is unattainable, explain what closure you were able to achieve and why that is the best possible result.

SECTION 5: REASONABLE CONTROL MEASURES CHECKLISTS

Purpose

To identify existing pollution prevention methods and evaluate the applicability of additional RCMs for the industrial processes at your facility.

Procedures

This section contains checklists of RCMs in four categories:

1. Flow Reduction
2. Pollutant Reduction
3. Operational Improvements
4. Potential MFRs

Each RCM listed on the checklists is numbered and described in the Appendix titled “Description of Reasonable Control Measures.”

- Review each measure and indicate if the RCM is already existing, applicable, or non-applicable to your facility.
- All measures, excluding those in the fourth section titled “Potential MFRs,” have been determined to be technically feasible and Cost Effective. (These measures cannot be found to be non-applicable due to the cost of implementation unless a detailed cost analysis is completed according to the instruction in Section 6)
- An economic evaluation should be performed to determine the applicability of the measures included in the “Potential MFRs” section only. This evaluation will be completed according to the instructions in Section 6.
- RCMs determined to be applicable must be included on the implementation schedule in Section 8.
- If a measure listed on the checklists is determined to be “Non-Applicable” for a reason other than the cost of implementation (mentioned above), an explanation must be included in the comments column or on attached documentation. The comments section may also be used to discuss cost/benefit analysis and how a measure will impact processes, product quality, and waste treatment.

Worksheet 5A

Flow Reduction: A separate checklist must be completed for each industrial process wastestream in the facility that requires treatment prior to discharge to the sanitary sewer.

Worksheet 5B

Pollutant Reduction: A separate checklist must be completed for each copper and/or nickel bearing or generating process in your facility.

Worksheet 5C

Operational Improvements: Complete one checklist for your facility.

Worksheet 5D

RCM Metals Reduction: Calculate estimated copper and nickel reductions resulting from the implementation of applicable RCMs as identified in Worksheets 5A, 5B, and 5C. Complete one worksheet for each process. Applicable RCMs must also be included in the completion of Sections 6, 7 and 8.

Worksheet 5E

Potential MFRs: A separate checklist must be completed for each copper and/or nickel bearing or generating process in your facility.

When determining applicability for these measures, an economic evaluation must be performed.

- Eliminate measures which are not applicable. The remaining applicable measures must be evaluated and scheduled for implementation just as other MFRs.
- Complete Section 6 for the remaining applicable measures to determine the resulting copper and/or nickel reduction. Worksheet 6B must be completed once for each process, rather than each project.
- Complete Section 7 for the remaining applicable measures to determine if they are Cost Effective.
- Measures found to be Cost Effective must be included in the completion of Section 8.

SECTION 6: WASTE MINIMIZATION PROJECTS EVALUATION

Purpose

To identify, describe, and calculate metal and flow reduction resulting from waste minimization projects. Forecast the costs of implementing each waste minimization project. Compare the annual costs of process operation before implementation to the annual operating costs after project completion.

Procedures

- Explore metal and flow reduction projects not previously mentioned in Section 5 that may be applicable to your facility.
- Complete one set of forms (6A-6F) for each project or group of interdependent projects identified.
- Include potential MFRs as identified in Worksheet 5E.

Worksheet 6A

Complete the worksheet and include a description and diagram of the proposed project or group of projects.

Worksheet 6B

Indicate if the resulting metals reduction is for copper, nickel, or both. For conditions before and after waste minimization project implementation, list the following information:

- Total mass of copper and/or nickel in the wastestream
- Amount of copper and/or nickel going to batch treatment and/or continuous treatment
- Amount of copper and/or nickel that will be discharged to the Sanitary Sewer System
- Process Flow rates

Describe how you determined the amount of copper and/or nickel discharged to the Sanitary Sewer System and why it will change.

Complete a separate worksheet for every process affected by a project.

Worksheet 6C

Record the quantity and unit cost of items that must be purchased for the construction and installation of the project. Use the information to determine the total cost of implementing the waste minimization measure, assuming funds are available without borrowing.

Total the project's purchase and installation costs with no financing, and enter the value where indicated.

Recalculate the total costs assuming a cost of funds at the prevailing interest rate. The prevailing interest rate is defined in the San Jose Municipal Code, Section 15.14.250 as:

the prime interest rate published in the Wall Street Journal plus 2% at the time the project costs are being determined.

Worksheet 6D

Determine the annual cost of operating and maintaining the process without implementing the waste minimization project.

Worksheet 6E

Forecast the annual cost of operating and maintaining the process after undertaking the waste minimization project.

Worksheet 6F

Compute the simple payback period for each project or group of projects, by dividing the initial investment cost by the change in annual operating costs.

SECTION 7: WASTE MINIMIZATION PROJECTS SUMMARY

Purpose

To summarize the cost of implementing the project and the amount of copper and/or nickel reduction achieved. For identified waste minimization projects, determine the expected copper and/or nickel reduction. The identified waste minimization projects will include any RCMs identified on form 5A-5C that can be installed, any potential MFRs from form 5E, and any other projects you have identified in section 6.

Procedures

Worksheet 7A

List the proposed waste minimization projects, including applicable RCMs and MFRs, their associated copper and/or nickel reduction, cost of installation, annual cost, and payback period.

Worksheet 7B

List the cost and associated copper reduction of the proposed waste minimization projects that were found to be cost effective. Cost effective as defined by the City Ordinance is described on page 2 of this report.

Worksheet 7C

List the cost and associated nickel reduction of the proposed waste minimization projects that were found to be cost effective.

Worksheet 7D

List the cost and associated flow reduction of the proposed waste minimization projects that were found to be cost effective.

SECTION 8: IMPLEMENTATION SCHEDULE

Purpose

To schedule the implementation of all applicable RCMs and MFRs.

Procedures

Worksheet 8

All applicable MFRs and RCMs must either be installed and operational or included in the Implementation Schedule.

- List all planned MFRs and RCMs by ID number and name.
- Provide the project implementation start and completion dates in the appropriate columns.

Progress reports on the implementation of RCMs and MFRs must be submitted with your SMR until all projects have been completed.

CERTIFICATION

Purpose

To schedule the implementation of all applicable RCMs and MFRs. This document certifies that the MAS has been completed by the appropriate personnel, obligations of the study are understood, and information included in the submitted MAS is true.

Procedures

Information and Implementation Certification

- Provide the requested information.
- Make sure the person that prepared the MAS and the Executive Officer that supervised the MAS preparation both sign the certification.

MASS AUDIT STUDY

INFORMATION and IMPLEMENTATION CERTIFICATION

I certify that:

1. I am knowledgeable of the processes that generate wastewater at this facility, or that I personally supervised the preparation of this MAS by someone under my authority.
2. I have authority to obligate this facility to implement the Mass Audit Study as submitted. I certify that all RCMs and MFRs will be implemented as described on the time schedule submitted to and approved by the City of San José Environmental Services Department (ESD).
3. I will notify the ESD in writing of any changes to the MAS and timeline due to planned or unforeseen circumstances or unexpected results. I understand that any changes are subject to ESD's approval prior to implementation. I understand that any changes to the assumptions used to determine any MFRs must be reported as an amendment to this MAS.
4. I certify that the information in the MAS is true to the best of my knowledge.

Prepared By: _____
Phone _____

Signature: _____
Date _____

Name of Principal or Executive Officer Phone _____

Signature of Principal or Executive Officer Date _____

Name of Facility

Address of Facility

Address of Discharge (if different)

Industrial Discharge Permit Number

APPENDIX A

DESCRIPTION OF REASONABLE CONTROL MEASURES

This description of Reasonable Control Measures (RCMs) comprises four distinct categories:

I. Flow Reduction

II. Pollutant Reduction

III. Operational Improvements

IV. Potential MFRs

Each category is described in the subsequent pages. The listed RCMs cannot be implemented on the same process line in all cases. Some RCMs are mutually exclusive; therefore, the facility must thoroughly evaluate each of its processes generating a copper or nickel bearing wastestream and select the specific RCMs that are most appropriate to implement. Employee safety and housekeeping issues should also be assessed as part of considering a measure.

If a measure listed on the checklists is determined to be “Non-Applicable,” an explanation must be included in the comments column or on attached documentation. The comments section may also be used to discuss cost/benefit analysis and how a measure will impact processes, product quality, and waste treatment.

The use of these guidelines cannot be interpreted as protection against enforcement action. It is up to the Discharger to ensure compliance with all local, state, and federal regulations. Additionally, the City will not endorse or reject a project because of any specific consultant, vendor, or product line mentioned.

I. FLOW REDUCTION METHODS

Decreasing discharge flow presents one of the main opportunities for pollutant reduction for both metal and non-metal bearing wastestreams. In many cases, the reduction of non-metal bearing wastestreams has a positive effect on mass loading reduction. In general, wastewater treatment equipment reaches an equilibrium, with little change in effluent concentration for a given range of influent concentration. By reducing the flow of wastewater through the treatment system, the mass being discharged will be reduced, especially if the effluent concentration remains constant. Therefore, the emphasis of the flow reduction section of this RCMP is on wastestreams that contain copper and/or nickel, or mix with such wastestreams prior to or during pretreatment. RCMs for wastestreams that discharge downstream of all pretreatment and do not contain copper and/or nickel are not required to be implemented, but must be included in the evaluation. Data must be available to show that these wastestreams do not contribute to copper and/or nickel loading to the WPCP.

Flow reduction includes practices such as reducing rinsewater discharges through reuse of rinse or treated water, and rinse agitation methods. Check with your Source Control Inspector for information on financial incentive programs for water conservation. The following flow reduction measures must be evaluated for each industrial process in the facility.

I-A RINSEWATER REDUCTION

Flow Restrictors and Manual Flow Controls

Flow restrictors limit the volume of rinsewater flowing through a running rinse system. Once the optimal flowrate has been determined, these devices are used to maintain constant flow of makeup water into the system. Industries often use batch process product lines in which rinse lines are manually turned on and off throughout the day. Pressure-activated control devices such as hand, knee, or foot-pedal activated valves can ensure that makeup water is not left on longer than necessary to maintain rinsewater quality after the rinse operation is completed.

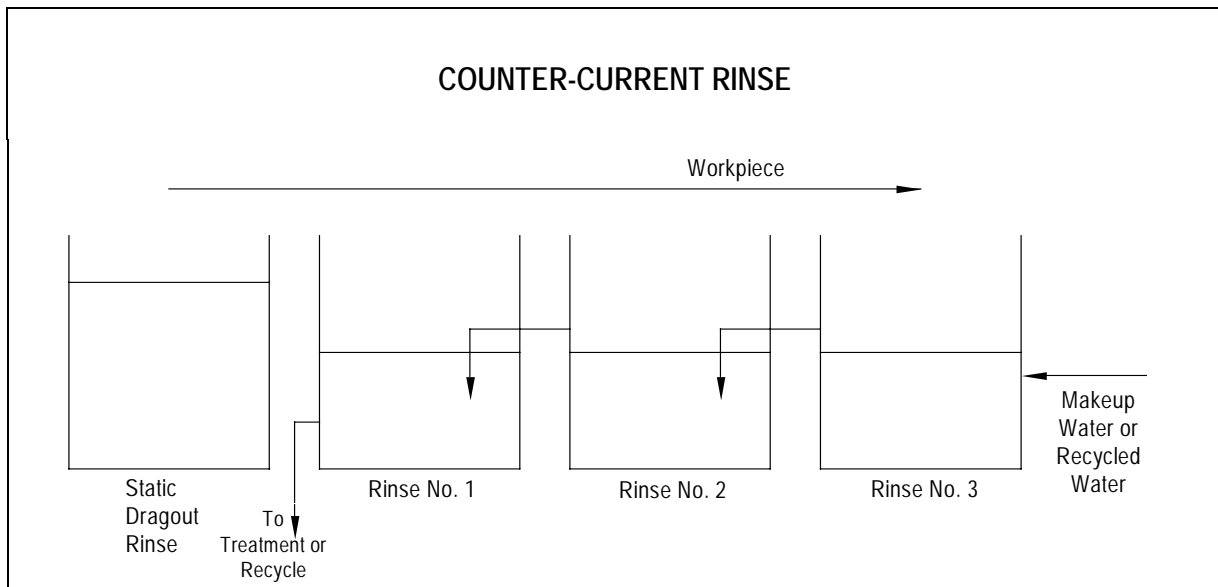
Counter-current Rinse Systems

Multiple counter-current rinse tanks can be used to provide sufficient rinsing while significantly reducing the volume of rinsewater used. A properly designed counter-current rinse system will provide sufficient agitation. A multi-stage counter-current rinse system can use up to 90 percent less rinsewater than a conventional single-stage rinse system. Actual water savings will vary depending on the number and configuration of tanks used.

The use of a multi-stage counter-current rinse system allows (1) greater contact time between the workpiece and the rinsewater; (2) greater dispersion of process chemicals into a rinse

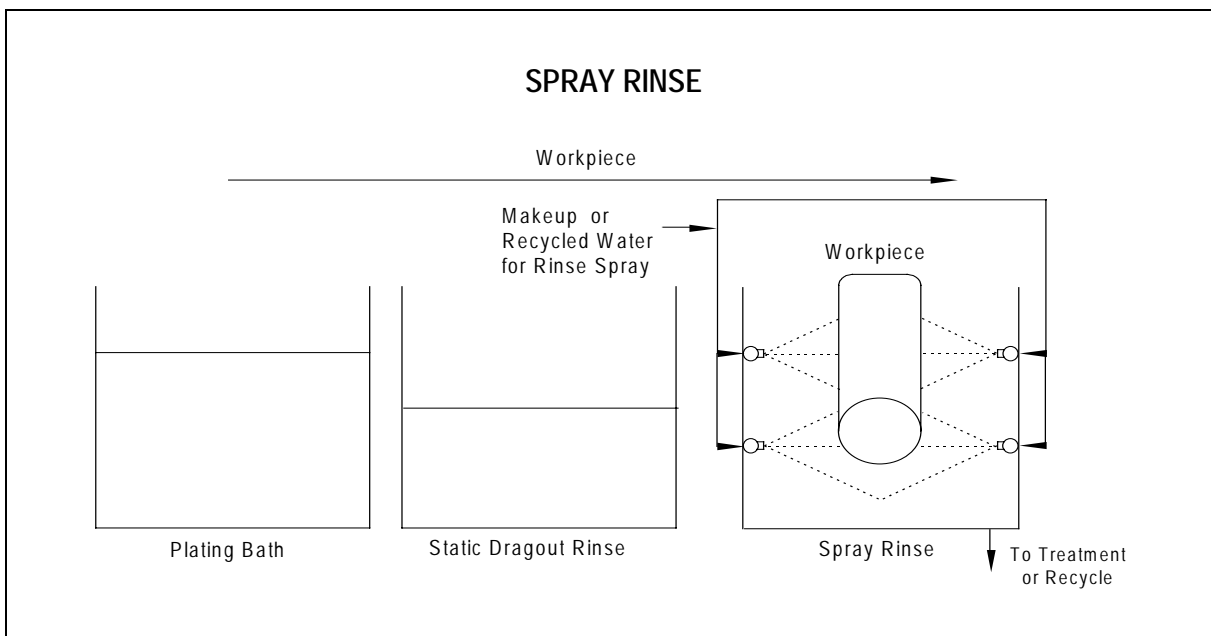
solution; and (3) more rinsewater to come into contact with the workpiece. In a multi-stage counter-current rinse system, the workpiece moves in the opposite direction of the rinsewater flow. The workpiece is immersed in successively cleaner rinse tanks. Counter-current rinsing should be operated with automatic and/or restricted water flow controls to allow minimal wastewater flow.

The disadvantage of multi-stage counter-current rinsing is that more process steps are required and additional equipment and work space is needed. If additional space is not available, the addition of multistage rinse systems may not be feasible. An option for a facility lacking floor space for additional tanks would be to reduce the size of the rinse tanks or to segregate existing tanks into multiple compartments (if workpiece size allows).



Spray Rinse Systems

Short duration spray rinsing uses between one-eighth and one-fourth the volume of water that a continuous flow rinse uses. It is highly effective for simple workpieces such as sheets. Spray rinses may not reach inner cavities of more complex workpieces. In this case, it can be combined with immersion rinsing. The application of spray rinsing as a first step in a rinse cycle is effective in reducing wastewater production. Spray rinses may be actuated manually or automatically, and may remain in operation for a short duration for workpiece rinsing.



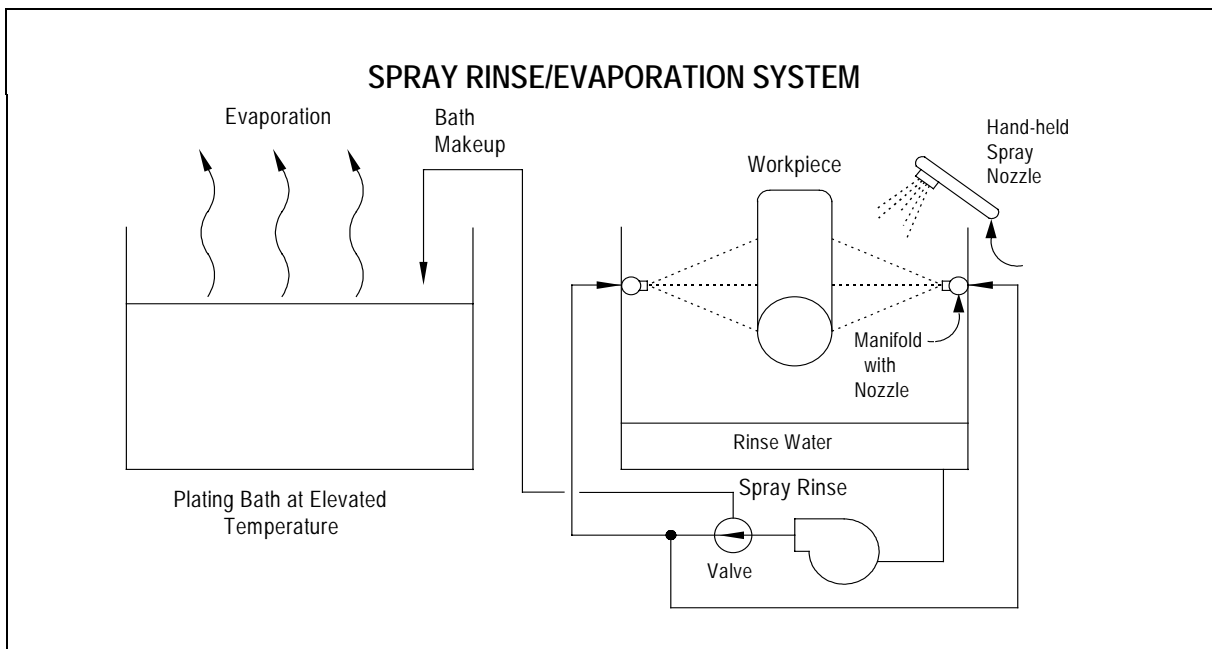
Spray Rinse/Evaporation Makeup Systems

Use of a spray rinsing system with evaporative makeup is an effective water minimization technique that can result in zero discharge for process tanks that provide elevated temperatures and resulting evaporation losses. To maintain product quality, this system may need to be combined with processes such as ion exchange, electrowinning, electrodialysis, or an occasional bath decant to reduce accumulation of impurities.

For example, a spray rinse system may be used in a heated chromium plating tank. Parts are rinsed off over the tank and the rinse water falls back into the plating tank. Therefore, in this case, no rinse wastestream is generated. Over time additional chromium must be added to the tank.

A spray rinse system may also use an empty spray rinse tank. A pump feeds spray nozzles located around the inside of the tank. The workpiece is lowered into the spray zone and the drippings fall to the bottom of the tank for recirculation. A final rinse can be done with a spray nozzle using either City water or deionized water. The used water can then be piped where needed for evaporation makeup and/or recycling. Evaporation makeup is an example of recycling that reduces waste generation.

A variation of this system is where the drippings fall into the rinse tank and are treated *in situ*. The collected rinse water is treated with an ion exchange cartridge and then it is reused to rinse additional parts. A conductivity probe located after the ion exchange column would be used to monitor the quality of the treated rinsewater. At a certain set point an alarm would sound, and then the ion exchange cartridge would then be replaced by the IU's personnel.



Oversprays/Foggers

Oversprays and foggers are variations of a spray nozzle system. Oversprays use high pressure water. Fog nozzles use high pressure air for atomization to produce a fine mist capable of greater workpiece penetration for rinsing and lower water use than for a conventional spray nozzle. It is more often possible to use an overspray or fogger rather than a spray nozzle directly over a heated plating bath to rinse the workpiece, because less water is added to the process bath using these alternatives. Workpieces are often also able to hang longer without drying out when oversprays or foggers are used. Employee safety and housekeeping issues should be evaluated when considering this measure.

Sensor Activated Rinses

Where appropriate, a contact switch can be placed on the tank so that when racks of parts are rested in a rinse tank, the feed line water valve is opened and the rinse cycle is activated. The control circuit is set to turn off the water flow within a predetermined time period after workpieces are removed from the rinse.

Timer Flow Controls

Timers are used with spray, continuous, and sensor activated flow rinses to shut the spray off after a predetermined period and allow only the amount of water flow necessary to rinse the parts. These controls work best when the workpiece or parts to be rinsed are homogeneous from one batch of parts to the next. If the parts are not homogeneous, the rinse timer may need to be adjusted for each batch.

Conductivity Flow Controls

A conductivity or pH meter can be used to control makeup water flow through a rinse system. A conductivity probe or pH cell is used to measure the level of dissolved solids or hydrogen ions in the rinsewater. When this level reaches a preset minimum conductivity or pH set point, the controller closes a valve that terminates the flow of water into the rinse system. When the concentration builds to the preset maximum level or pH set point, the controller opens a valve that initiates the flow of water.

Since most metal finishers have non-homogeneous production, the level of dissolved solids in the rinse solutions will likely fluctuate. Therefore, conductivity control equipment is especially valuable to the metal finishing industry. Use of these controllers can reduce product reject rates by improving water quality. Tank contents must be mixed thoroughly in order to ensure homogeneity of the water sensed by the probe, thereby resulting in effective operation of the water flow controller. Routine and frequent cleaning of probes may be necessary to ensure product quality.

Note - some probes are especially susceptible to "fouling", or "blinding," causing a film to appear on the probe. This film inhibits the transfer of ions across the probes semi-permeable tip. Hence, the readings that these probes deliver to the meter do not represent the contents of the bath. Therefore, daily cleaning and calibration is recommended. Over time you may find that a lower frequency is acceptable for your particular process.

I-B REUSE OF RINSE/TREATED WATER

Use in Fume Scrubber/Cooling Towers

Effluent from a final rinse operation, which is usually less contaminated than in-process rinsewaters, can be used as makeup water for fume scrubbers and cooling towers. This rinsewater may need pH adjustment prior to using it as makeup water in fume scrubbers and cooling towers. Final effluent (effluent after treatment) can be used as makeup water for the fume scrubbers and cooling towers. Check with your City Source Control Inspector prior to implementing this measure.

Reuse of Process Rinsewater

After rinse solutions become too contaminated for their original rinse process, they may be useful for other rinse processes. Process lines and rinsewater requirements should be evaluated so rinse system arrangements can be developed to take advantage of rinsewater reuse opportunities.

Effluent from a rinse system that follows an acid cleaning bath can be reused as influent water to a rinse system following an alkaline cleaning bath. This configuration can actually improve rinse efficiency. The neutralization reaction reduces the viscosity of the alkaline drag-out film. In some instances, unwanted precipitation of metal hydroxides onto the cleaned workpieces can occur.

Other rinsewater recycling opportunities are also available. Alkaline cleaning rinsewater effluent can be used as rinsewater for workpieces that have gone through a mild acid etch process. Effluent from a final rinse operation, which is usually less contaminated than other rinsewaters, can be used as influent for rinse operations that do not require high rinsewater quality.

Note, some rinsewaters can be "improved" with the use of in-line ion exchange columns, and/or carbon filters. By doing so contaminants that may be present in this rinsewater are removed.

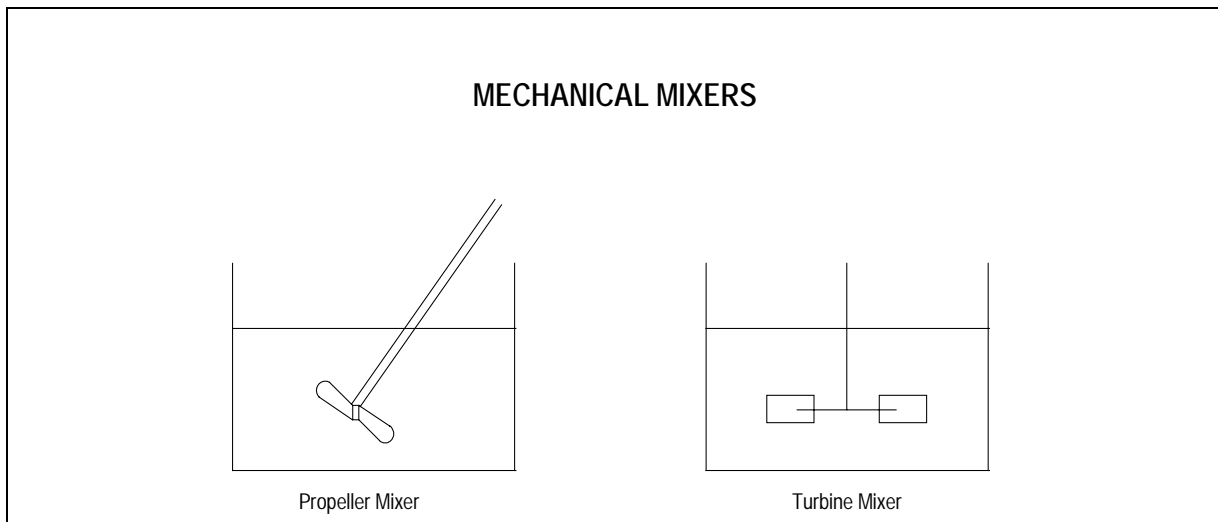
Reuse of Treated Wastewater

Treated water may be reused as rinsewater for non-critical rinsing steps. By use in a non-critical step, the quality of the workpiece is not negatively impacted.

I-C RINSE AGITATION MEASURES

Mechanical Mixers

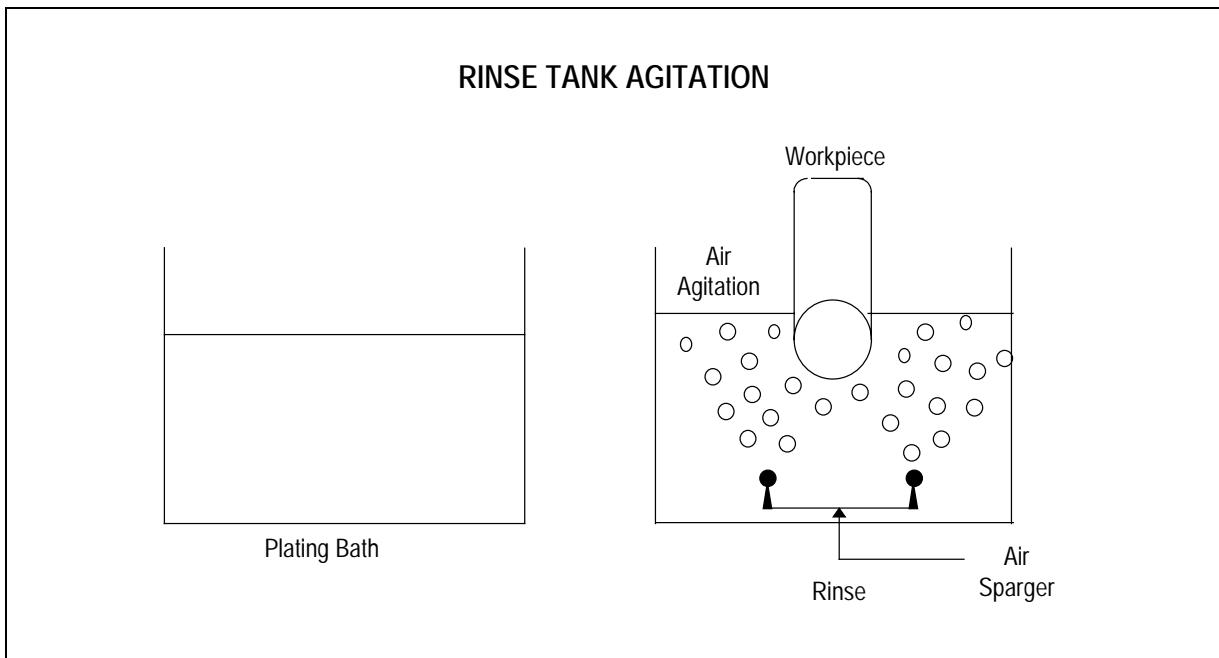
The purpose of mechanical mixing, like that of air sparging, is to maintain the contents of the tank in a completely mixed state. With mechanical mixing, turbulence is induced by means of rotating impellers, such as propellers, turbines, and paddles.





Air Agitation

The most important factor in the design of rinse systems is ensuring complete mixing of rinsewater, thus eliminating short circuiting of feed water and utilizing the entire rinse cell volume. Agitating the rinsewater by using forced air or water is the most efficient method for creating complete mixing during rinse operations. This can be achieved by pumping either air or water into the immersion rinse tank. Air agitation can provide the best rinsing because the air bubbles create improved turbulence to remove the chemical process solution from the workpiece surface. This type of agitation can be performed by pumping filtered low-pressure air into the bottom of the tank through a pipe distributor (air spargers).

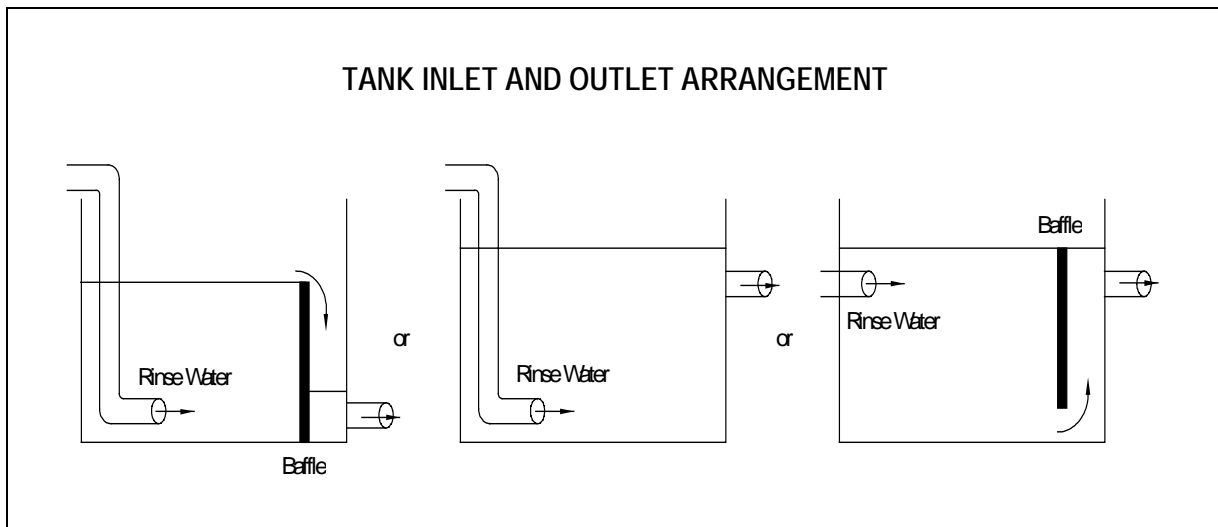


Sonics

Rinse agitation methods, in addition to maintaining a mixed state, also provide better workpiece cleaning. Ultrasonic waves are used to create small vacuum bubbles in liquid tank contents. When these bubbles collapse, they cause a strong cleaning action on nearby parts. Ultrasonic cleaning is particularly useful for parts with hard to reach surfaces, and may allow operation at a lower temperature. Caution is advised on the use of this measure in acidic rinses.

Tank Arrangement

Tank size, shape and internal configuration should be arranged such that rinsewaters circulate thoroughly and do not “short circuit” from the inlet directly to the outlet. Be sure to arrange all piping in a fashion that would eliminate a back siphon potential. Use gravity flow where possible. It should be noted that an “air gap” prevents back siphoning.



"The Microchemistry" Approach

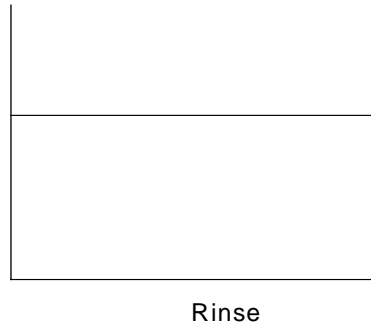
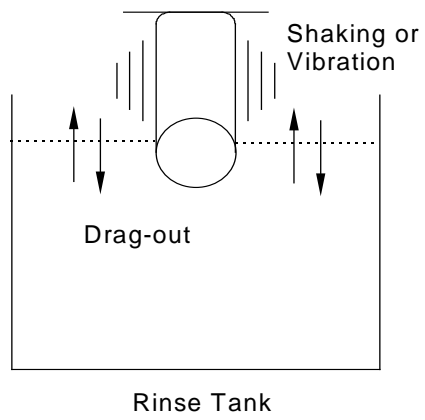
Tanks should be sized so that they are just big enough to fit the workpiece: typically, the tanks should be about 1" larger for the width, depth, and length than the workpiece/rack. By doing so, the amount of chemicals, the volume of water, the amount of energy needed to heat the tank, and the amount of pretreatment used in the manufacturing processes are minimized. Significant savings can be realized by using this approach. In addition to the aforementioned savings, one metal finisher using this approach has reported a drop in reject rates from 10% down to 2%! Therefore, even more money is saved through the reduction in reject rates.

Employee safety is also improved because the employees don't have to strain themselves. They do not have to lift the racks as high to clear the tanks, which may lead to a reduction in lower back injuries.

Workpiece Agitation

If the configuration of the workpiece permits, moving the workpiece rack in the water or creating turbulence in the feed water will agitate the workpiece and rinsewater. Since many metal finishing plants operate hand rack lines, operators could easily move workpieces manually by agitating the hand rack. Rinsing is more effective if the pieces are raised and lowered in and out of the rinse tank rather than agitating the pieces while they are submerged. The effectiveness of this system depends on proper instruction of the operator and monitoring by the supervisor. This technique is effective for use with workpieces with large surface areas and interior surfaces that will not effectively drain.

WORKPIECE AGITATION



II. POLLUTANT REDUCTION

Reducing the amount of pollutants to be treated or disposed of helps facilities meet compliance limits and reduce operating costs. Pollutant reduction practices include methods such as extending bath life, using alternative chemistry, and modifying drag-out methods and tanks.

Note: All pollution reduction measures described below must be evaluated for each copper or nickel bearing or generating process.

II-A EXTENDING BATH LIFE

Process Bath Filtration

Filtration systems can be used to remove contaminants that build up in process baths and shorten bath life. To avoid contamination related defects in the plating resulting in high reject rates, baths should be continuously filtered to remove impurities. Continuous filtration can extend the life of the bath, thereby reducing the waste produced by treating spent process baths. Filters should be sized and operated according to manufacturer's specifications. When organic build up is a problem in baths, use of carbon filter cartridges is appropriate.

Process Bath Replenishment

Depletion and contamination diminish process bath effectiveness. Chemicals essential to the process are depleted by plating and are removed as drag-out on workpieces. Contaminants are introduced into the bath when workpieces are not completely rinsed from previous baths and from airborne sources. Replenishment by decanting the bath is one option that should be considered before discarding the bath. When the entire effectiveness of the bath falls off, part of the bath can be decanted and discarded and fresh water and chemicals can be added to replace the decanted portion. Decanted portions from the baths may also be appropriate to use for waste treatment.

Frequency of Bath Changes

Frequent bath analysis can extend the bath life by determining the necessary replenishment chemistry needed to keep the bath within the manufacturer's specification. Extending bath life results in less waste to be treated and/or hauled off-site.

Note, by performing chemical analysis in conjunction with process rates, you may be able to determine a replenishment schedule based on processed workpieces. In this way, you minimize chemical usage, costs, and pollutants added to the system.

II-B NEW CHEMISTRY/MANUFACTURING

Alternate Chemistry

The use of alternate chemistry can modify process parameters to extend bath life beyond normal bath discard criteria. Some process chemicals that are considered hazardous waste when spent, can be replaced with chemicals that can be treated or recycled on-site. This can reduce waste management costs, without negatively impacting your product quality.

Less Chelated Chemistry

The use of non-chelated or less chelated process chemicals in baths can reduce hazardous waste generation. Chelators are used in chemical process baths to allow metal ions to remain in solution beyond their normal solubility limit. Chelators are usually found in baths used for metal etching, cleaning, and selective electroless plating. Once the chelating compounds enter the wastestream, they inhibit the precipitation of metals because the chelating agent will not precipitate, and additional treatment chemicals must be used. These treatment chemicals end up in the sludge and contribute to the volume of hazardous waste, increasing disposal costs.

In addition, many of the spent process baths containing chelators cannot be treated on-site and are containerized for off-site disposal, also adding to waste disposal costs. Non-chelated process chemistries can be used for many cleaning processes. It is unnecessary to keep metals in solutions that have been removed from workpiece surfaces during cleaning and etching. Those metals can be allowed to precipitate, and the process bath can be filtered to remove solids.

Evaporation to Concentrate Wastes

Evaporation has been successfully used in a number of ways to recover plating bath chemicals. In one technique, static rinsewater is evaporated to reduce its volume sufficiently to allow the remaining concentrate to be returned directly to the process bath. In another technique, it is the water from the process bath that is evaporated, making room in the bath for rinsewater to be added as makeup. The water vapor can be condensed in some systems and reused in the rinse system.

II-C DECREASE AMOUNT OF DRAG-OUT

Operate Bath at Lower End of Manufacturer's Suggested Concentration

Chemical process baths have a manufacturer's recommended concentration range in which they are effective. By maintaining baths at the lower end of the concentration range, the concentration of drag-out is reduced and the life of rinsewater is extended, thereby reducing wastewater. In the case of a static rinse, change out is less frequent. For a running rinse, the flow can be reduced.

Note – Tests should be conducted to evaluate the minimum permissible chemical concentrations for the bath to meet product quality standards. Additionally, the replenishment rate versus the number of parts processed may be tracked to maximize the efficient use of chemicals.

Increased Bath Temperatures

Increasing the bath operating temperature lowers both the viscosity and the surface tension of a solution, thus reducing drag-out at an increased energy expense. To make up evaporative water losses, static drag-out tank concentrate or a spray rinse above the process tank can be used. Increased bath temperatures cause chemicals to be more reactive, thus enabling use of lower concentrations. Be careful, however, since increased temperatures can cause increased reaction rates.

Drip Bars

Maximizing drip/drain time for all baths will significantly decrease the amount of drag-out. Workpiece drainage depends on the operator. The time allowed for drainage can be inadequate if the operator rushes to remove the workpiece rack from the process bath and place it in the next tank. Installation and use of a bar or rail above the process tank to hang the plated workpiece will ensure that adequate drainage time is provided prior to rinsing. Although increased drainage time can have some negative effects due to drying, some baths are not affected. Rinsing over heated baths with oversprays or foggers will allow workpieces to hang longer without drying. Maximizing drip/drain time is one of the most cost effective, pollution reduction methods available.

Slower Workpiece Removal

The faster an item is removed from the process bath, the thicker the film on the workpiece surface and the greater the drag-out volume will be. **The effect of slower workpiece removal is so significant, that it is believed that most of the time allowed for withdrawal and drainage of a rack should be used for withdrawal only.** When workpieces are removed from a process bath manually, it is difficult to control the speed at which they are withdrawn. Nevertheless, supervisors and management should emphasize to process line operators that workpieces should be withdrawn slowly. This information should be incorporated into the process operation instructions. At plants that operate automatic hoist lines, hoists should be adjusted to remove the workpiece racks at the slowest possible rate.

Workpiece Orientation

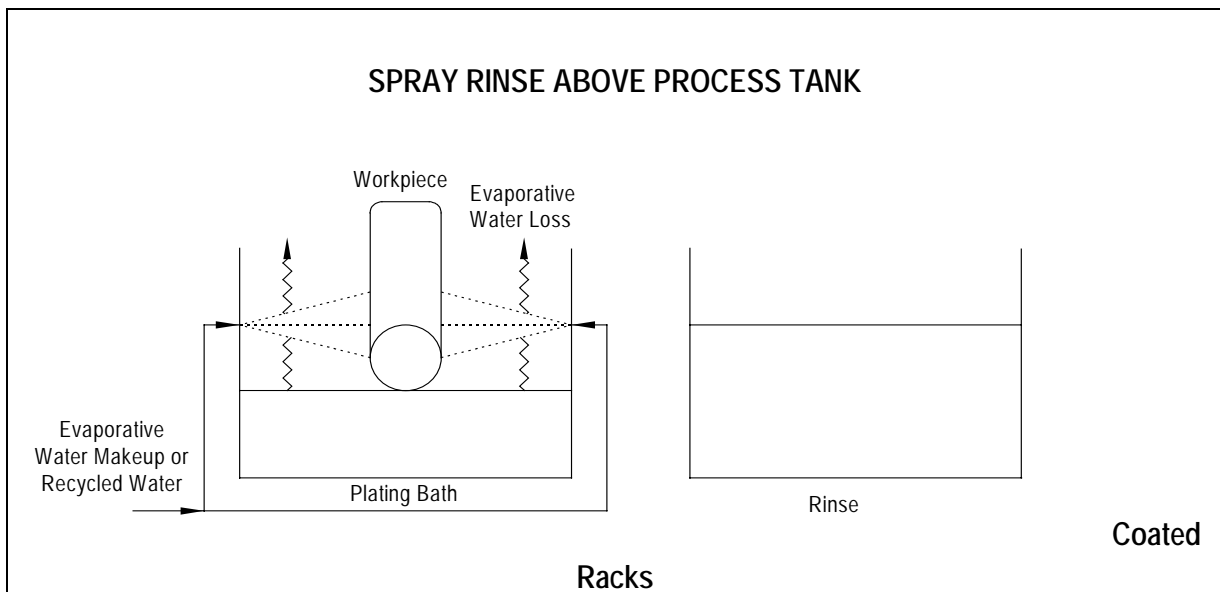
The workpiece shape, size, and position in the rack holder will affect the amount of drag-out loss. Although the optimum workpiece position is best found experimentally, the following guidelines were found to be effective:

- Orient the major flat surfaces as close to vertical as possible.
- Rack with the longer dimension of the workpiece horizontal.
- Rack with the lower edge tilted from the horizontal so that the runoff is from a corner rather than an entire edge.

Shaking or vibration of a rack may dislodge drag-out adhering to a workpiece after removal from process baths.

Spray Rinses Over Process Tanks

A spray rinse can be used above a process tank kept at an elevated temperature to make up evaporative water losses while recovering bath solution. The spray rinses must be adjusted to control water makeup rate. Application of water as spray droplets or fine mist onto the workpieces above the process tank improves drainage recovery of drag-out.

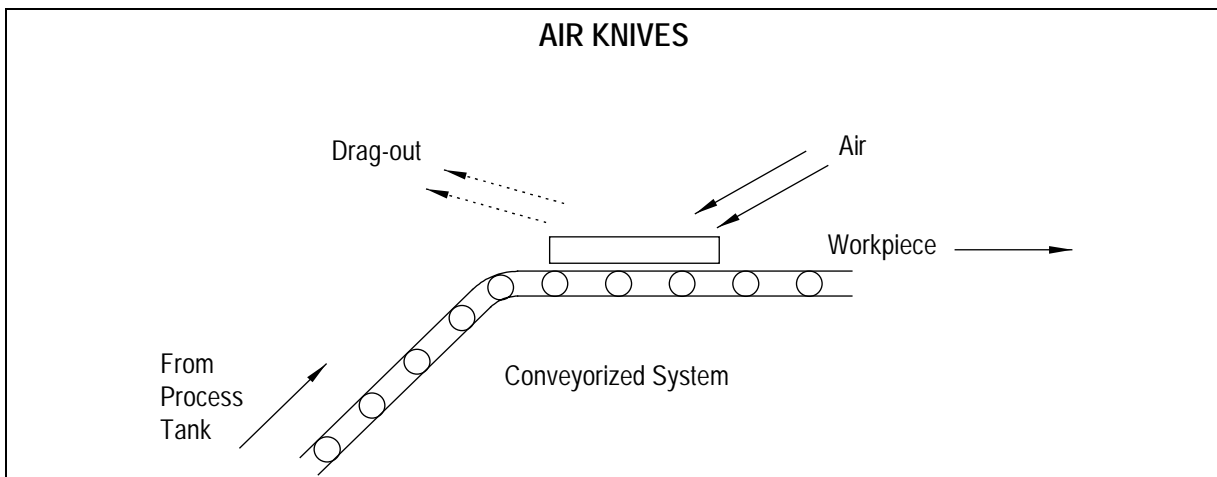


The introduction of metals into a process bath can result from parts that dissolve because of contact with process solutions. Racks are typically coated with plastic or other inert materials and minimize the amount of metals that are introduced into the bath. The use of coated racks reduces the metal rack area to be stripped.

In addition to minimizing the amount of extraneous metal entering into the bath, the plastic coated racks do not "consume" any stripping chemicals. If the racks were not covered with an inert material then the stripping chemicals would react with the metal and less stripping chemicals would be present in the bath.

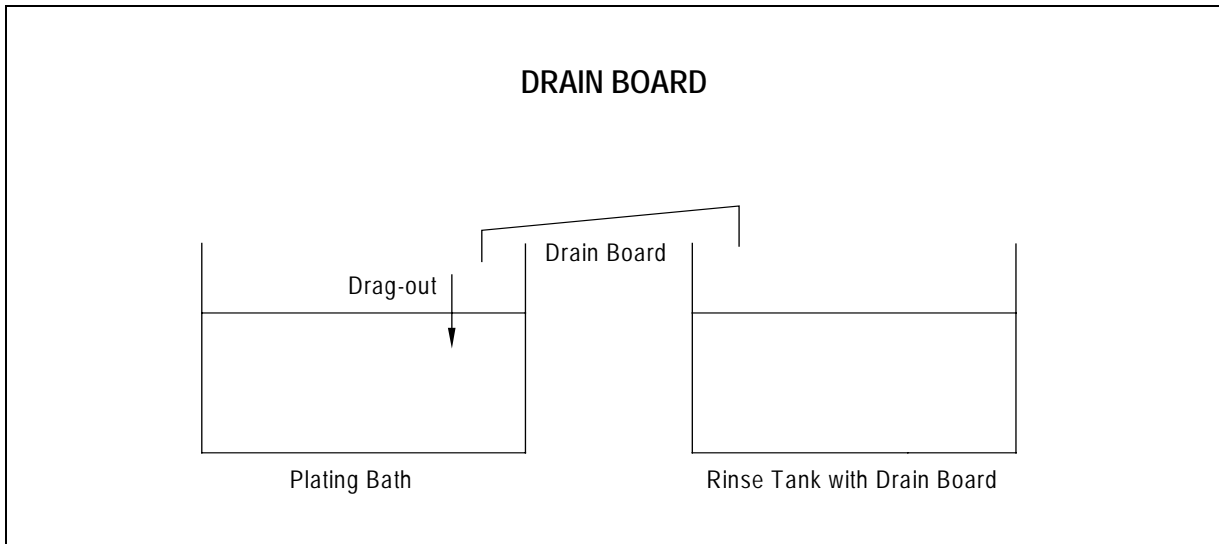
Air Knives

In an automated, conveyORIZED process, air knives perform essentially the same function as "squeegees" do namely, to reduce workpiece drag-out by removing the layer of concentrated solution adhering to the board. An air stream is directed to blow solution off the workpiece and back into the process bath. Air knives aid in clearing solutions off the whole workpiece surface and the holes, where squeegees can not reach. Air knives are particularly useful when the bath evaporation rate is too low to accommodate the water flow that spray nozzles would add back to the tank. Drawbacks of this method include drying of the workpiece and applicability to relatively flat workpieces only.



Drain Boards

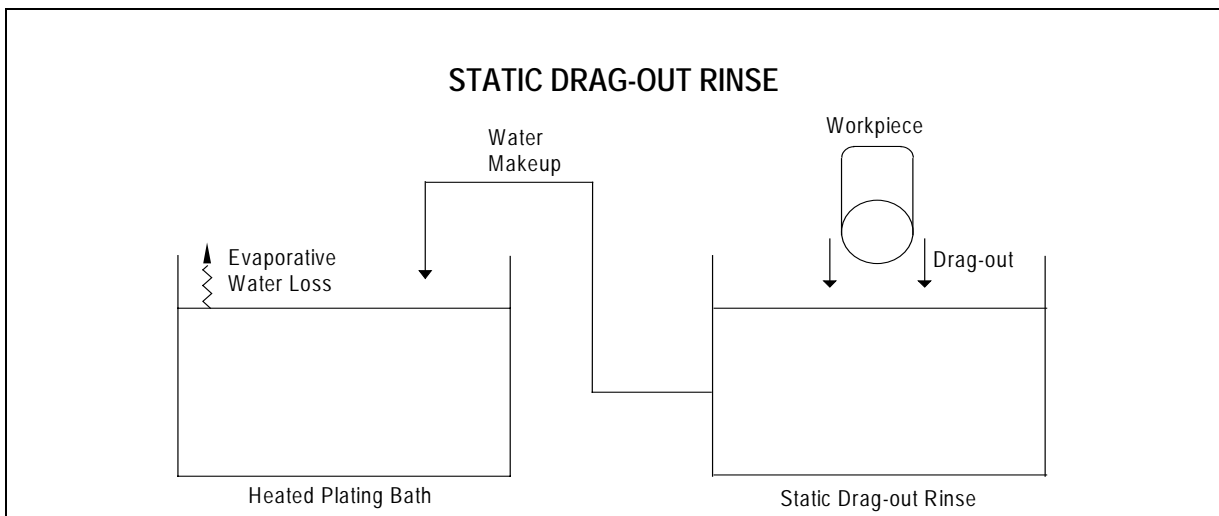
Drain boards are the simplest method of drag-out recovery, which capture drippings from racks being transferred from tank to tank. Drain boards save chemicals and reduce rinsewater requirements. The drain board should be positioned at an angle that allows the captured solution to flow by gravity back to the appropriate process tank. Drain boards should have raised edges that act as berms to prevent liquids from running off the edges.



II-D REUSE OF DRAG-OUT SOLUTION

Static Drag-out Rinses

Static drag-out rinses are generally used immediately after a process bath to collect and concentrate drag-out prior to a flowing rinse. The static drag-out rinse solution is used to replenish the process bath. High-temperature evaporative water losses can be made up by periodic addition of drag-out rinses to the process bath. Deionized water should be used for static drag-out rinse solution so that makeup water impurities are minimized, and are not added to process solutions. Drag-out solution from baths with low evaporative losses, may be treated by evaporation and electrowinning, to reduce volume and concentration prior to waste treatment.



Heating Drag-out Tanks

Heating drag-out tanks reduce both the viscosity and the surface tension of a solution, thereby reducing drag-out. The evaporative water losses, which result from heating the drag-out tank, increase the concentration of the drag-out solution.

Reuse in Process Baths

As workpieces continue to be passed through the drag-out rinse tanks, the concentration of chemicals in the tanks will increase. Drag-out solutions may be reused in the process bath where they originated.

III. OPERATIONAL IMPROVEMENTS

Pollution prevention can be enhanced by operational improvements such as treatment modifications and administrative measures. The most direct way to improve the quality of the effluent that is discharged to the sewer is to reduce the concentration and flow of chemicals that require waste treatment. The next most direct way is to improve waste treatment processes. Using or modifying commonly used administrative measures can optimize source reduction efforts. Evaluate your whole discharge facility, not individual process lines, using the following operational improvements.

III-A TREATMENT MODIFICATIONS

Better Precipitation Chemistry

Significant improvements in reducing the volume of sludge produced and therefore disposal costs, have been reported by dischargers who changed the chemicals and flocculants used in treating wastewater streams. A variety of chemistries and polymers are available on the market. Trade associations and vendors can be a valuable resource for this type of information. Jar testing any new chemistry is essential to confirm vendors' and other's claims, and to demonstrate probable compliance before attempting a full-scale trial.

Improved Clarifier Baffles

When major cleaning, repairs, and/or maintenance activities are performed on clarifiers, it may be appropriate to replace the clarifier baffles with a better design. Improvement in clarifier efficiency has been observed at companies who modified baffles. Wastewater treatment equipment vendors and trade associations are valuable resources for information on new and efficient industry-specific baffle design.

Flow Equalization for Treatment Systems

Flowrates through treatment systems should be controlled to provide a consistent flow for efficient waste treatment. Highly variable flowrates can easily "upset" clarifiers and membrane filters. Using an equalization tank installed prior to the treatment system can control fluctuations in flow.

Batch Treat Concentrated Solutions

All spent process baths and drag-out solutions must either be shipped off-site for recycling or disposal, or be batch treated on-site to remove the metals before the solution is further treated with the dilute rinsewater waste that has not yet been treated. This pre-treatment can be done by various methods such as electrowinning and chemical treatment. The wastewater that is

left over after batch pre-treatment can then be used for other treatment or be metered into the main rinsewater wastestream, depending upon its physical and chemical composition.

III-B ADMINISTRATIVE MEASURES

Statistical Process Control

The use of statistical process control has been applied in both the monitoring of wastewater treatment and in monitoring aqueous “plating-related” processes, although it is more common in general manufacturing. The best example of such technique is the use of process control charts (sometimes called Shewart control charts), which plot the mean and/or standard deviation of a previously determined performance variable versus time (or parts processed, or square footage) to predict trends and measure variation in the process. The desired result is a stable process that obtains maximum results with minimum materials.

Inventory Control

Inventory or other controls can be used to assure that chemicals in containers are completely used prior to opening a new container. The complete use of material can reduce the amount of wasted raw materials that adds to the total volume of waste. Inspecting containers before accepting them will also prevent the receipt of leaking or damaged containers which can lead to a hazardous material spill and unexpected clean up and disposal costs. Another inventory control measure is to use the materials on a first-in-first-out basis. This can reduce chances of chemicals expiring on the shelf before use.

Inspection/Maintenance of the Facility

Inspections of the facility’s production, storage, and waste treatment facilities should be conducted regularly to identify leaks and improperly functioning equipment which may lead to waste generation. These inspections should include piping systems, storage tanks, defective racks, air agitation systems, automated flow controls, and operators’ techniques. Frequent inspections can identify problems before they become significant. Identified problems should be fixed using appropriate corrective measures. Preventative maintenance should be incorporated into the facility’s maintenance protocol. Inspections should be coordinated with the preventative maintenance schedule to reduce waste generation and improve process operating efficiency.

Employee Training

Educating employees on source reduction techniques and concepts will allow them to develop innovative ideas specific to your facility. This may reduce disposal costs and minimize liability. Workers should be encouraged to offer source reduction suggestions. Owners, managers, and operators of a business must make a full time, ongoing commitment to source reduction efforts. Personnel should be re-trained periodically to affirm that RCMP procedures are followed and that employees know why it is beneficial to do so. Success

or results of efforts should be advertised as positive reinforcement. As new developments occur in hazardous materials management, employees should be kept informed in order for them to perform their duties more efficiently. Employee manuals should be reviewed periodically to include up-to-date information. Employee training seminars can be organized through trade associations and/or consulting firms that offer training in handling hazardous materials as part of their package of services.

Training personnel on proper withdrawal rates and the procedure for positioning workpieces on racks can help reduce the amount of drag-out that is taken from the process tanks. Designated and properly trained personnel should mix bath solutions, because bath makeup procedures can have a major impact on the amount of generated waste, the rate of required treatment, and the ability to recycle wastewater. Designating a limited number of personnel to mix chemicals may improve the consistency of the baths and minimize costly mistakes.

IV. POTENTIAL MFRs

The methods discussed have been observed to have wide applicability in many, though not necessarily all, of the processes used in your industry. Other methods which have limited applicability and depend on process is automation are the suitability of static rinses with different chemistries or other site-specific circumstances. ESD encourages each IU to pursue new pollution prevention measures, whether included on this list or not. This is particularly true for IUs who indicate there are no “new” projects on the list of rinsewater reductions they can consider for any process.

This section describes several non-traditional approaches to waste treatment and recovery. Although effective in the removal of heavy metals, these measures may be expensive, maintenance intensive, and effective for small flows only. Unlike the previous RCMs, these measures may not be cost effective for some IUs. In determining applicability, evaluate the cost effectiveness of each measure if implemented at your site. The following pollution reduction measures must be evaluated for each copper or nickel bearing or generating process.

Use of Scrubber/Cooling Water in Process

The water from fume scrubbers has been shown to be suitable for rinsing in certain cases. Spent cooling water or steam condensate can also be employed for rinsing, if technically permissible and economically justified. One example is the use of scrubber water in a caustic soap rinse.

Segregation of Wastestreams

Wastestream segregation is highly recommended, because it facilitates rinse flow reuse and material recycling. Since segregating rinse flows eliminates the mixing of non-hazardous wastes with hazardous wastes, flows are easier and less expensive to treat and dispose. Segregated acidic and alkaline wastestreams allow potential recycling plant applications. Segregation of specific solvent-bearing wastestreams allows on-site recycling or off-site recovery. Segregation of metal-bearing wastewaters is important in plant operations. Wastestreams containing chelated metal complexes require special treatment.

Electrolytic Bath Purification

Electrolytic bath purification is used to remove trace metal impurities. The process requires placing an anode and a cathode in the rinse solution. As current passes from anode to cathode, the metallic impurities deposit on the cathode along with the plating metal. The metallic deposit can be reclaimed or sold as scrap metal.

Chemical Treatment

Chemical treatment usually involves the addition of oxidizing agents that “strip” the organic brighteners from a bath. Then, new chemistry can be added to replenish the bath.

Physical Treatment

Physical treatment includes chilling the bath to precipitate out insoluble impurities such as carbonates.

Process Automation

Computerized process-control systems can be used for parts handling and process bath monitoring.

Double-treat Core for PCBs

The use of these boards by an IU can be considered a RCM due to the incidental effects rather than any direct effects. PCB manufacturers using or considering “double-treated” boards indicate that use of such boards will eliminate or reduce the need for processes like pumice scrubbing (a very significant water savings) and black oxide. Elimination of such processes may free up space usable for different projects.

Direct Metallization

The electroless copper process is currently used in the PCB manufacturing industry to achieve connections between circuit patterns on each side of a circuit board and between inner layer patterns of multilayered boards. This process uses some hazardous chemicals, namely chelated copper and formaldehyde. Direct Metallization replaces the electroless copper process. There are several types of Direct Metallization processes, including carbon based, palladium based, and conductive polymer based systems. The environmental advantages of changing to one of these processes may include elimination of formaldehyde, reduction of chelated copper waste, and conservation of process water. Other potential advantages include higher throughput due to a conveyORIZED process.

Use of Deionized (DI) Water

DI water can be used to replace tap water for process bath makeup and rinsing operations. Natural contaminants found in tap water, such as carbonates, chlorides, bicarbonates, sodium, calcium, magnesium, potassium, and phosphates, can reduce rinsewater efficiency, minimize the potential for drag-out recovery, shorten process bath life, and increase the frequency of process bath treatment. These contaminants also add to sludge volume when removed from wastewater during treatment.

Ion Exchange

Ion exchange can be used to remove metals from dilute rinse solutions. The rinsewater is passed through a series of resin beds that selectively remove cations and/or anions. As the rinsewater is passed through the bed, the resin exchanges ions with the inorganic ions such as metals in the rinsewater. The metals are removed from the resin by regenerating the resin with an acid and/or alkaline solution. The metals can be removed from the regenerant solution by using electrolytic recovery techniques, or the regenerant can simply be batch treated as a spent concentrate. The treated rinsewater is of high purity and can be returned to the process bath (though filtration of salts and/or organics may be needed for reuse), or returned to the rinse system for reuse. A common use of ion exchange for process bath recovery is for the treatment of rinsewater from a chromic acid process bath.

Electrowinning

Electrowinning is the recovery of the metallic content from high concentration solutions using the electroplating process. It is employed to recover a variety of metals, including cadmium, tin, copper, solder alloy, silver, nickel, and gold. In a typical electrowinning process, special cathodes from which the recovered metal can be stripped, are mounted in a plating tank. As the current passes from anode to cathode, the metal deposits on the cathode. This type of system generates a solid metallic deposit that can be reclaimed or sold as scrap metal. Electrolytic recovery can be performed continuously in a drag-out tank, or as a batch process on spent solutions.

Electrodialysis

Electrodialysis employs selective membranes and an electric potential as the driving force to separate positive and negative ions in the solution into two streams. To accomplish this, the rinse solution is passed through cation and anion-permeable membranes. Cation exchange membranes allow cations such as copper or nickel to pass; while anion exchange membranes pass anions such as sulfate, chloride, or cyanide. The concentrated solutions can be recycled to the plating baths, while the ion-depleted water can be recycled through the rinse system. While electrowinning is most efficient for recovering metals from concentrated solutions such as spent plating baths, electrodialysis is very effective on dilute solutions like waste rinsewaters.

Reverse Osmosis

Reverse Osmosis (RO) is a pressure-driven membrane separation process. The process uses a semi-permeable membrane that permits the passage of purified water while not allowing dissolved salts to pass through. The most common application of RO in metal finishing operations is the recovery of drag-out from nickel rinses. RO membranes are not suitable for solutions that have high oxidation potential such as chromic acid.

Membrane Filtration

Membrane filtration is a pressure-driven cross-flow filtration process that uses a porous membrane to separate suspended solids from liquid. Once the contaminants in the wastewater have been put into a form that makes them filterable, they may be removed by membrane filters. A basic filtration unit consists of a concentration tank, a process (recirculation) pump, and a train of membrane modules. Indicators are provided to monitor system pressure and filtrate flow.

Some fabric based cross-flow filtration processes require the use of a "pre-coat" onto the filtering media prior to the introduction of the material to be filtered. The "pre-coat" traps the solids yet lets the liquid portion of the mixture filter through. Typically, this process is halted once the filtrate's flow rate drops below a certain value. The fabric is then back-washed and the solids laden slurry is collected in another vessel. The process is then repeated until the tank containing the original mixture is emptied.

One problem observed with pressure-driven cross-flow filtration is that the rate of filtration decreases over time, and eventually the membrane may become "blinded" depending on the material that is being filtered. Once, the membrane is blinded then additional maintenance must be performed such that the filter can operate properly again. However, in extreme cases, the membrane needs to be replaced entirely.

After chemical pretreatment is completed, the wastewater from the reaction tank is collected in the concentration tank and pumped at a high velocity through the filter membrane tubes into each membrane module. The turbulent flow, parallel to the membrane surface, produces a shearing action that minimizes deposition of solids on the membrane. Clear water (the filtrate or permeate) filters through the membrane, and the remaining wastewater (the concentrate) containing the suspended solids is recirculated to the concentration tank. The filtrate flows to a filtrate neutralization system by gravity for pH adjustment before being discharged to the sanitary sewer.

Note, that in this process, as well as in the fabric based cross-flow filtration process, the permeate is typically clear, but may not necessarily be colorless. That is why in some cases a "pre-coat" of powdered activated carbon is used to remove some if not all of the color from the permeate. Powdered activated carbon can remove some organics that cause discoloration of the filtrate/permeate.